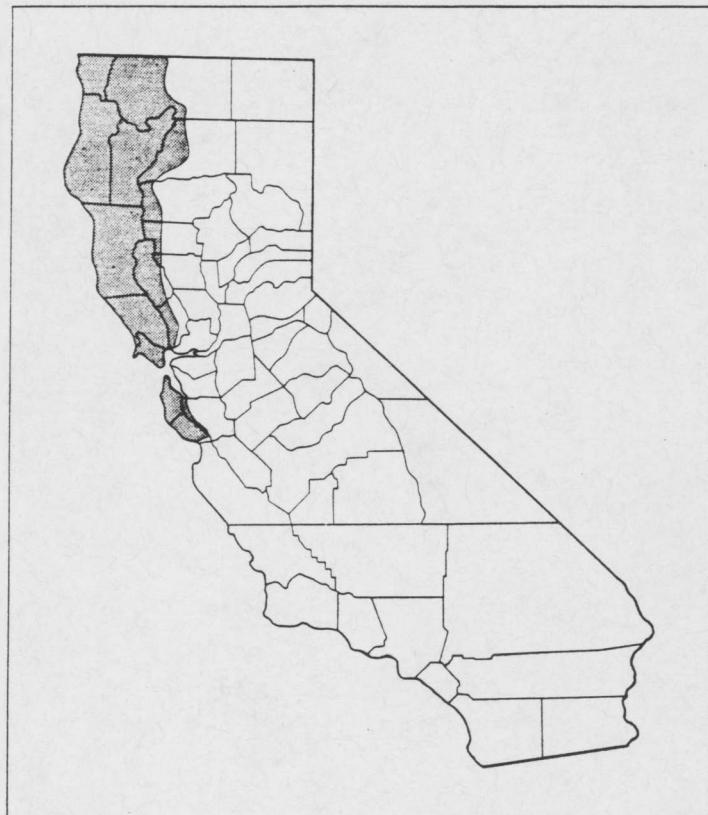


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CULL FACTORS FOR FOREST-TREE SPECIES
IN NORTHWESTERN CALIFORNIA

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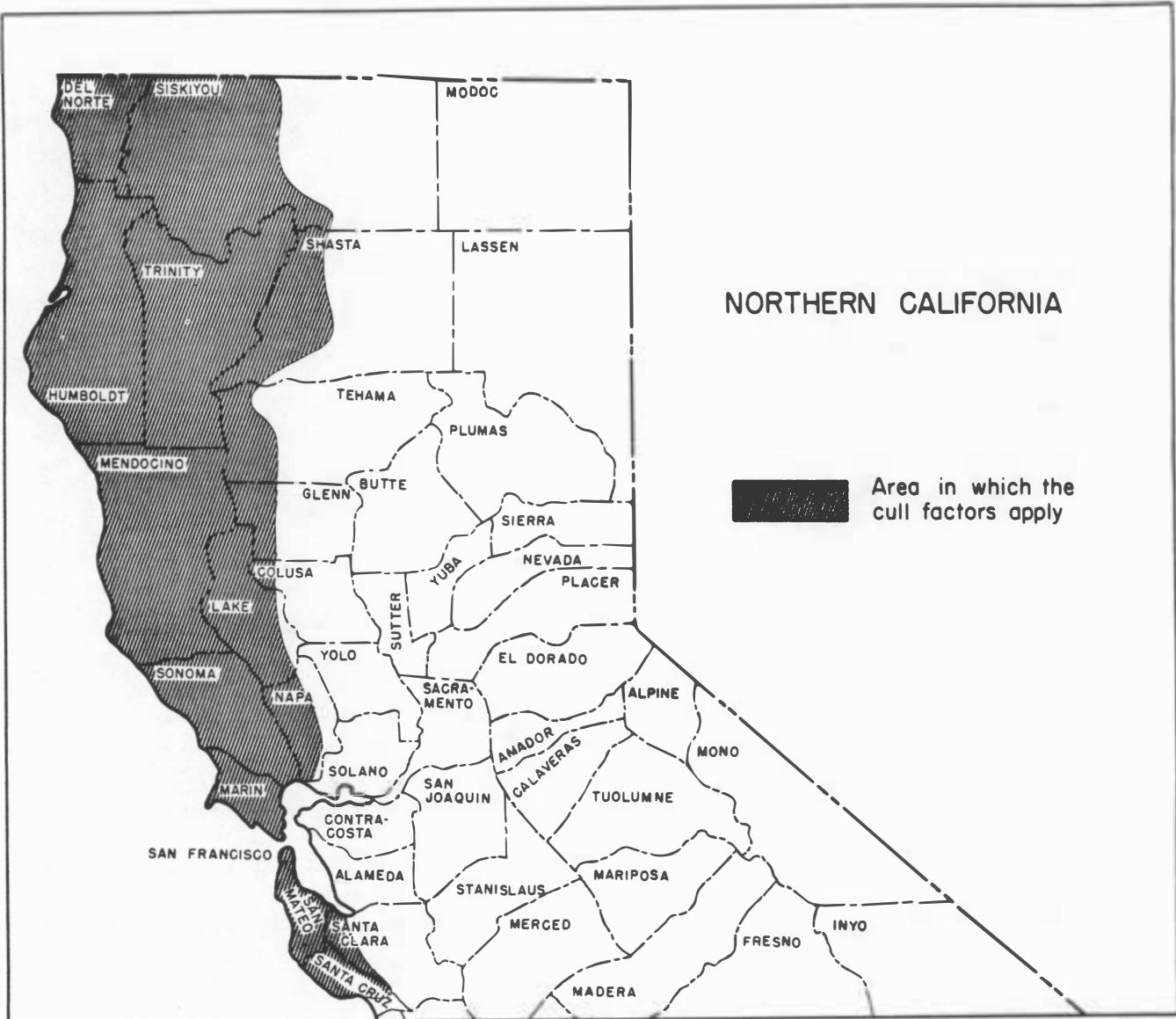
From industry: Numerous lumber and logging companies have cooperated by extending permission to collect data at their woods operations. The California Oregon Power Company and the Pacific Gas and Electric Company assisted in locating study areas along new rights-of-way where clearing was being done.

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CONTENTS

	Page
Introduction	1
What cull factors are	1
Cull indicators	2
Descriptions	2
Suggested symbols	4
Application of cull factors	6
Cull factors for coniferous species	7
Douglas-fir and white and red firs	7
Ponderosa and sugar pines	20
California incense-cedar	21
Cull factors for hardwood species	22
Common and scientific names of trees and fungi mentioned	27
Figures 1-12	28



NORTHERN CALIFORNIA

Area in which the
cull factors apply

INTRODUCTION

The part of a living tree that is not merchantable because of defect is termed cull. The defect may be decayed wood, shake, fire scars, or poor form. Hence cull in living forest trees is of primary economic importance in the lumber industry, and the success or failure of a lumbering operation often depends on the accuracy with which estimates of cull have been made. This is true not only because cull reduces the volume of sound wood available, but also because it increases handling costs in logging and milling.

In older stands of mature and over-mature trees, cull may constitute a large volume loss of wood material. California has many stands of this type. The proportion of cull often varies considerably in different parts of a forest region, and it varies widely between species, as, for example, between ponderosa pine and white fir. The amount of cull present in a living tree is often difficult to estimate. Cruises will be in error if not correctly discounted for cull, even though gross volume estimates are accurate.

As a part of the Forest Survey in California, the Division of Forest Pathology has undertaken field studies and the assembling of available data to determine average percentages of cull in the various tree species in the forests of the State. While primarily for use to determine net volumes in the Forest Survey compilations, the cull factors which have been determined are published here in anticipation that they may be useful to other public foresters and foresters of the lumber industry.

The results herein summarized are applicable principally to the Coast Range Pine and the Redwood--Douglas-fir subregions of northwestern California. Cull factors are presented for the principal conifers and hardwoods of these two subregions, excepting redwood. It is anticipated that cull factors for redwood and some of the minor species will be determined as additional field studies are completed.

Cull, as employed in this paper, does not include loss of volume due to breakage in logging.

The factors given here are preliminary and subject to correction when additional data are obtained.

WHAT CULL FACTORS ARE

When the amount of cull is expressed as a percent of the gross volume of a tree or stand, the percentage is termed the cull factor.

Two types of cull factors are used. One type is applied to individual tree volumes, the other to stand volumes. That applied to individual trees is based on the cull found in association with specific indicators such as conks, fire scars, or broken tops, and is called an

indicator factor. Indicator factors are given for the true firs and for Douglas-fir. The type of cull factor applied to stand volume is based on total cull from all causes and is called a flat factor, or general factor. It is used for the other conifers and for the hardwoods.

CULL INDICATORS

Cull in white fir, California red fir, and Douglas-fir is comparatively greater than in most of the other commercial conifers. Also, there is considerable variability in amount of cull in these species within a subregion. For these reasons, flat factors applicable to an entire subregion were considered inadequate to provide the desired accuracy of net volumes for these three important species. Fortunately, external indicators are associated with the principal kinds of defect in trees of these species. The following indicators of cull were found to be the most useful:

Conks of Indian paint fungus, Echinodontium tinctorium;
Conks and swollen knots of ring scale fungus, Fomes (Trametes) pinii;
Conks of quinine fungus, Fomes officinalis (F. laricis);
Fire scars and other butt scars;
Conks of velvet top fungus, Polyporus schweinitzii;
Dead or broken tops.

Descriptions

Conks of the Indian paint fungus (fig. 1)^{1/} are probably recognized by all cruisers who work in white and red fir stands, as they are the most common conks on these firs. They are hard, woody, hoof-shaped and perennial, ranging from a few inches to over a foot in width. The upper surface is black, dull, rough, and cracked, and the under-surface is grayish, level, and thickly set with hard, coarse spines (fig. 2). The interior, or context, is rusty-red or brick-red in color. The conks usually occur on the underside of dead branch stubs. When they occur high in a tree among the live branches they are often difficult to see, especially if the light is poor. A single conk usually indicates limited decay, and several conks some distance apart often indicate a multiple infection and usually a cull tree. If limited cull is indicated by a single conk or a compact group of conks, the extent of cull is related to the location of the infection in the bole. Cruisers should note the location by lower 1/3, middle 1/3, or upper 1/3 of the "merchantable bole", or sawlog portion of the bole. If any 2 conks are separated more than 5 feet vertically, the cull should be considered as extensive. Indian paint fungus conks are rarely found on Douglas-fir.

Conks of the ring scale fungus (fig. 3), rarely found on the true firs, are the most common conks found on Douglas-fir and are readily

^{1/} All illustrations are at end of report, pages 28 to 30.

recognized by all experienced cruisers. These variable perennial conks may be thin shell-shaped to bracketlike or irregularly hoof-shaped. They range from 1 or 2 inches to more than a foot in width, with an average width of 4 to 8 inches. The upper surface is rough, dull grayish or brownish black, with approximately concentric furrows parallel to the lighter brown margin. The under surface is a grayish to rich brown in color, and the mouths of the small tubes of which it is composed vary from small and almost circular to large and irregular. On living trees the conks usually issue from knots or branch stubs along the bole. When they occur high in the crown of a large tree they are difficult to spot from the ground, and considerable experience is necessary for a cruiser to develop an ability to locate them readily. As with the Indian paint conks, the ring scale conks indicating limited cull (none separated by more than 10 feet vertically) should be recorded as occurring on lower, middle or upper 1/3 of the merchantable bole. Cull is considered as extensive when any 2 conks are separated by more than 10 feet vertical distance.

Swollen knots or punk knots (fig. 4) are also excellent indications of ring scale fungus decay, although in the California forests these indicators are usually accompanied by conks. The swelling results from an attempt to heal over a punk knot and may indicate the beginning of a new conk, but usually indicates an abortive conk or the point from which an old conk has dropped. Cruisers may easily recognize swollen knots on living trees and should consider them as analogous to conks.

Burl-like growths (fig. 5) should not be confused with swollen knots, as they are not ordinarily indicators of cull.

Conks of the quinine fungus (figs. 6 and 7) are not as commonly known to woodsmen as those of the Indian paint fungus and ring scale fungus because they are not prevalent. But they are distinctive in appearance and are easily recognized once they have been identified. They are long, cylindrical, pendulous or roughly hoof-shaped. They attain considerable age, and when they develop in the cylindrical shape they may be 10 to 18 inches or more long. The upper surface is chalky white or brownish, rough and zoned, whereas the under surface is white, when fresh, with small, round pores. When dried, the pore surface darkens (fig. 7), becoming light brown in color. The substance of a conk is white, soft and cheesy when young, and rather crumbly and chalky when old and dry, with an intensely bitter taste. The conks issue from knots or old wounds, and often are found in association with broken tops in Douglas-fir. They may be found on either of the true firs or on Douglas-fir, and a single conk usually indicates a cull tree.

Old fire scars or catfaces (fig. 8) on the butts of trees are abundant in the California forests. They provide points of entrance for various fungi, as do dwarfmistletoe cankers and other serious basal trunk wounds that expose the heartwood. Decay fungi entering such wounds often cause a large part of the cull.

The common butt rot caused by the velvet top fungus is often found associated with fire scars in Douglas-fir, and frequently this fungus produces conks (figs. 9 and 10) on the scar or on the ground at the base of a tree that does not have a visible scar, in which case they indicate butt rot comparable to that associated with fire scars. The cruiser should record conks of velvet top fungus as old fire scars. On the ground (fig. 9), when viewed from above, the conk is more or less circular in shape and sunken in the center, tapering to a short thick stalk. The upper surface of fresh conks is velvety, concentrically zoned, and reddish brown in color with a tan margin; the under surface is greenish in color and turns red-brown when bruised. The mouths of the tubes are large and irregular in shape. The substance of the conk is moist and cheesy. The conks turn a deep red-brown or blackish brown when old and they become corky and easily broken. On the tree (fig. 10) the conk is a thin bracket, and frequently one or more brackets grow one above the other. The conks are annual and develop most abundantly during moist weather in the late summer and fall, but their dried remains may be evident for a year or more following their development. Often the broken remains of old conks on the ground are the only indication a cruiser has of extensive decay in the tree butt.

Old broken or dead tops (fig. 11) afford excellent points of entrance for decay fungi and, when low enough to involve the sawlog portion of the bole, they usually indicate extensive cull in Douglas-fir and some cull in white and red firs. All such broken or dead tops should be recorded by the cruiser. Recently killed or broken tops, or dead or broken tops so high that they do not involve the sawlog portion of the bole, may not indicate a cull loss if the trees are harvested soon.

There are other cull indicators that are of minor importance and usually more difficult to recognize, and some cull may exist that is not associated with a recognizable indicator. Likewise, some of the cull indicators may be missed by the most experienced cruisers, so that a portion of existing cull is not associated with recorded indicators. To compensate for this "hidden" cull and overlooked indicators, the cull factors given in column number one of tables 1 to 6, inclusive, for quinine fungus conks, or for scattered Indian paint fungus or ring scale fungus conks, have been increased somewhat over actual cull averages for these indicators.

Suggested Symbols

To apply the cull factors in tables 1 to 6 effectively, a cruiser must be thoroughly familiar with the cull indicators used. In cruising, each sample tree must be carefully examined and existing indicators noted in the tally. The indicators and their 7 symbols that were used by the Forest Survey are as follows:

<u>Indicator</u>		<u>Symbol</u>
Single or compact group of)	(On upper 1/3 of	
Indian paint fungus conks (no)	(merchantable bole	+
conks separated by more than)		-
5 feet vertical distance))	(On mid-1/3 of	-
or)	(merchantable bole	+
Single or compact group of)	(On lower 1/3 of	-
ring scale fungus conks (no)	(merchantable bole	+
conks separated by more than)		-
10 feet vertical distance))		
Indian paint fungus conks separated by more than)		
5 feet vertical distance, or ring scale fungus conks)		++
separated by more than 10 feet vertical distance.)		
Quinine fungus conk or conks		+
Old fire or other butt scar, or velvet top fungus conk.		V
Old broken or dead top extending into otherwise merchantable bole.		d.t.

A single tree may have more than one cull indicator. Therefore cull factors were computed both for each indicator when occurring alone on a tree and for two or three indicators when occurring together on the same tree. In all, 16 indicator classes were established, any one of which may be applicable to a tree, depending on the combination of indicators present. These classes are arranged in 16 numbered columns in tables 1 to 6, which give the cull factors for Douglas-fir and true firs. The factors in the number one columns cull the entire heartwood of the portion of the bole to which the table applies. Cull in the sapwood is indicated only by a dead or broken top. The combination of entire heartwood plus sapwood cull was not included in the present tables because, in the Forest Survey, column number one automatically indicated a cull tree. The Forest Survey classifies as cull any commercial coniferous tree that does not have 25 percent or more of its gross board-foot scale in merchantable material, and trees that are culls on a board-foot basis are also cull on a cubic-foot basis.

The tables for cull in the sawlog portion of the bole apply to that part of the tree from an 18-inch stump to an average utilizable top. The utilized-top-diameters used in compiling the tables were based on data collected by the California Region of the Forest Service (fig. 12, page 30).

APPLICATION OF CULL FACTORS

Cull factors, like the figures in volume tables, are averages and should not be expected to give accurate estimates of net volume for individual trees. Furthermore, the amount of cull varies from locality to locality within the subregions, and flat factors, which are derived from region-wide averages of cull, should not be expected to give accurate estimates for stands of limited area. Indicator factors, being derived from averages for individual indications of cull, will in general apply more accurately to smaller areas than the flat factors.

The cull factors applying to board-foot volumes are based on Scribner scale for the hardwoods and Scribner Decimal C scale for the conifers. However, since the factors are expressed as percentages, they will apply generally to the International 1/4-inch scale, as well. The amount of cull in board feet was determined by standard Forest Service scaling practice, in which a pine log is considered to be totally cull when more than 66-2/3 percent of its gross board-foot volume is cull and logs of other species are considered totally cull when more than 50 percent of the gross board-foot volume is cull.

All trees, whether considered cull trees or not, were included for determination of the various cull factors. For this reason, the flat factors given for pines and incense-cedar should be applied to gross stand volumes including cull trees. The factors for the hardwoods of sawlog size are so arranged that cull trees may be either included or excluded. In cruising hardwood stands, a veteran cruiser may wish to tally cull trees separately from the merchantable trees, while one inexperienced in cruising hardwoods should tally all trees regardless of the amount of cull.

To use the cull factors for the true firs and for Douglas-fir, a cruiser may record the cull for individual trees either by using the symbols given on page 5 or by using the column number (1 to 16) as given in the tables. Where trees are tallied by species, diameter, and number of logs, defective trees bearing one or more of the various cull indicators may be recorded in the cruiser's tally by writing the appropriate column number in parentheses alongside the figure for number of logs. Then allowance for cull may be made from the cull factor tables at the same time that volumes are determined from the volume tables.

The indicator factors for Douglas-fir and the true firs may be helpful to markers in deciding which trees should be cut and which would be best to leave. It should be remembered, however, that the cull factors are averages and hence the marker can improve the estimate of cull for individual trees by exercising good judgment in applying the average cull factors. This is especially true in respect to trees with fire or other butt scars and trees with broken or dead tops, since the age of the injury is directly related to the extent of decay. In general, the older the injury the greater will be the extent of decay. Disregarding the age of the injury, the lower a dead or broken top lies within the merchantable bole, the greater will be the extent of cull.

Data pertinent to the application of the various cull factors are given preceding the tables.

CULL FACTORS FOR CONIFEROUS SPECIES

Douglas-fir and White and Red Firs

The cull factors that apply to the board-foot volume of the sawlog portion of the bole are given first, for Douglas-fir in table 1 and for white and red firs in table 2. Next are the factors that apply to the cubic-foot volume of the sawlog portion of the bole, Douglas-fir in table 3 and white and red firs in table 4. Factors in the final pair of tables apply to the cubic-foot volume of the entire bole, from an 18-inch stump to a 4-inch top diameter inside the bark.

The cull factors for Douglas-fir are given for three different site index groups, and those for the white and red firs, for four site index groups. If users wish to combine two or more site index groups, approximate values may be computed by averaging the factors in the groups to be combined, plotting the values and drawing smoothed curves.

The figures in the columns within each site index group were read from smoothed curves. If d.b.h. classes other than those given are desired, the values may be determined by interpolation, or by replotted the curves and reading off the intermediate values.

The cull factors in these six tables are based on the dissection and detailed measurements of 898 defective trees at 67 locations in northwestern California, and a study made by J. S. Boyce involving 2,633 trees on 38 areas in Oregon and Washington. Checks made at various localities in northern California proved the applicability here of Boyce's data for conks in Douglas-fir in Oregon and Washington. Basis of the cull data for different types of indicators, by number of study areas and number of defective trees dissected, was as follows:

Species	Types of indicators --					
	Conks		:Fire scars, etc		:Dead or broken tops	
	Areas	Trees	Areas	Trees	Areas	Trees
	Number	Number	Number	Number	Number	Number
White and red firs	7	263	11	274	9	90
Douglas-fir	1/ 38	1/ 2,633	17	166	23	105

1/ Based on study reported in: Boyce, J. S. Decay and other losses in Western Oregon and Washington, U. S. Dept. of Agr. Tech. Bull. 286, 1932.

Table 1.- Percent of cull in Douglas-fir by site and D.B.H. class
Board-foot volume of saw-log portion of bole

Cull percentage of gross board-foot volume (Scribner Decimal C) of saw-log portion of bole - indicated by																
DBH Class	F. officinalis conk or F. pini conks vertically separated more than 10 feet	Old fire scar	Dead or broken top extending into merchant- able bole	Fire scar plus dead or broken top	Single or compact group of F. pini conks -- none separated by more than 10 feet vertical distance, on											
					Lower 1/3 of merchantable bole				Middle 1/3 of merchantable bole				Upper 1/3 of merchantable bole			
					Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
12	100	79	3	82	79	79	82	82	100	100	100	100	43	100	43	100
14	100	70	10	80	70	70	80	80	77	95	79	100	39	100	39	100
16	100	63	17	80	63	63	80	80	48	91	66	100	35	98	35	98
18	100	56	23	79	56	56	79	79	43	87	62	100	31	87	33	89
20	100	50	28	78	50	50	79	79	40	83	58	100	28	78	32	82
24	100	41	36	77	43	43	79	79	35	76	52	93	22	63	36	77
30	100	33	44	77	39	39	83	83	31	64	48	81	17	50	44	77
36	100	29	47	76	38	38	86	86	29	58	47	76	14	43	47	76
42	100	28	51	79	41	41	92	92	29	57	51	79	12	40	51	79
48	100	31	61	92	45	45	97	97	28	59	61	92	10	41	61	92
54	100	35	75	100	47	47	100	100	27	62	75	100	8	43	75	100

SITE INDEX: 125 AND UNDER

12	100	79	3	82	79	79	82	82	100	100	100	100	43	100	43	100
14	100	70	10	80	70	70	80	80	77	95	79	100	39	100	39	100
16	100	63	17	80	63	63	80	80	48	91	66	100	35	98	35	98
18	100	56	23	79	56	56	79	79	43	87	62	100	31	87	33	89
20	100	50	28	78	50	50	79	79	40	83	58	100	28	78	32	82
24	100	41	36	77	43	43	79	79	35	76	52	93	22	63	36	77
30	100	33	44	77	39	39	83	83	31	64	48	81	17	50	44	77
36	100	29	47	76	38	38	86	86	29	58	47	76	14	43	47	76
42	100	28	51	79	41	41	92	92	29	57	51	79	12	40	51	79
48	100	31	61	92	45	45	97	97	28	59	61	92	10	41	61	92
54	100	35	75	100	47	47	100	100	27	62	75	100	8	43	75	100

SITE INDEX: 150

12	100	61	3	64	61	61	64	64	79	87	82	100	36	97	36	97
14	100	52	9	61	52	52	61	61	49	85	65	100	30	82	30	82
16	100	47	16	63	47	47	63	63	40	83	58	100	26	73	26	73
18	100	43	22	65	43	43	65	65	35	79	54	97	24	67	24	67
20	100	40	28	68	41	41	69	69	32	72	51	91	21	61	26	68
24	100	35	36	71	40	40	76	76	27	62	48	83	18	53	36	71
30	100	30	44	74	39	40	83	84	25	55	46	76	15	45	44	74
36	100	27	49	76	38	43	87	90	24	51	49	76	13	40	49	76
42	100	27	52	79	37	44	89	97	23	50	52	79	12	39	53	79
48	100	27	56	83	35	44	91	100	22	49	56	83	11	38	56	83
54	100	28	59	88	32	43	90	100	21	49	59	87	10	38	58	88
62	100	30	62	95	29	41	88	100	20	50	62	92	9	38	61	95
72	100	31	63	100	26	40	86	100	19	50	63	94	7	38	63	100

SITE INDEX: 175 AND 200

12	100	69	2	71	69	69	71	71	49	83	63	100	43	100	43	100
14	100	62	8	70	62	62	70	70	43	81	61	100	38	100	38	100
16	100	56	13	69	56	56	69	69	38	78	59	100	33	95	33	89
18	100	48	17	63	48	48	65	65	35	75	57	98	28	76	28	76
20	100	40	21	61	43	43	64	64	32	71	55	96	25	65	25	65
24	100	32	27	59	38	38	65	65	28	60	51	85	19	51	27	59
30	100	26	34	60	35	38	69	73	24	50	48	69	14	40	34	60
36	100	23	40	63	32	41	72	80	21	44	46	64	12	35	40	63
42	100	22	46	68	29	40	75	85	19	41	46	65	10	32	46	68
48	100	23	50	73	26	39	76	88	18	41	50	66	9	32	50	73
54	100	25	52	77	24	38	76	90	17	42	52	67	8	33	52	77
62	100	26	54	80	22	37	76	91	16	42	54	68	7	33	54	80
72	100	27	55	82	21	36	76	92	15	42	55	68	6	33	55	82

Table 2.- Percent of cull in white and red firs by site and D.B.H. class
Board-foot volume of saw-log portion of bole

DBH Class	Cull percentage of gross board-foot volume (Scribner Decimal C) of saw-log portion of bole - indicated by Single or compact group of <i>E. tinctorium</i> conks - none separated by more than 5 feet vertical distance, on																							
	F. officinalis conk or <i>E. tinctorium</i> conks vertically separated more than 5 feet				Dead or broken top extending into merchant- able bole				Fire scar plus dead or broken top				Lower 1/3 of merchantable bole				Middle 1/3 of merchantable bole				Upper 1/3 of merchantable bole			
	Old fire scar	(1)	(2)	(3)	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top				
	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)											
SITE INDEX: 100																								
12	100	100	23	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100					
14	97	84	22	95	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97					
16	96	73	21	91	95	95	96	96	96	96	96	96	96	96	92	96	92	96	96					
18	95	65	20	85	93	93	95	95	95	95	95	95	95	95	84	95	84	95	95					
20	96	59	19	78	90	90	95	95	95	95	95	95	95	95	71	95	71	95	95					
24	99	55	17	72	84	84	94	94	94	98	94	99	99	55	95	55	95	95	95					
30	100	54	15	69	76	76	88	88	93	100	93	100	44	95	44	95	44	95	95					
36	100	56	12	68	71	71	82	82	81	98	84	100	38	94	38	94	38	94	94					
42	100	58	10	68	70	70	79	79	70	96	74	100	34	92	34	92	34	92	92					
48	100	60	8	68	70	70	78	78	66	95	72	100	30	90	30	90	30	90	90					
54	100	62	6	68	69	69	76	76	64	95	70	100	27	88	27	88	27	88	88					
62	100	61	8	68	68	68	76	76	63	94	68	100	22	83	22	83	22	83	83					
SITE INDEX: 125 AND 150																								
12	90	89	19	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90					
14	90	76	17	85	85	85	90	90	89	90	90	90	83	90	83	90	83	90	90					
16	91	65	15	79	81	81	90	90	88	91	91	91	68	89	68	89	68	89	89					
18	92	55	14	69	78	78	90	90	86	92	92	92	58	88	58	88	58	88	88					
20	93	50	13	63	76	76	89	89	84	93	93	93	51	86	51	86	51	86	86					
24	95	47	10	57	72	72	82	82	80	94	90	95	40	82	40	82	40	82	82					
30	98	47	8	55	68	68	76	76	71	94	79	98	31	75	31	75	31	75	75					
36	100	46	7	53	66	66	73	73	62	94	69	100	26	71	26	71	26	71	71					
42	100	46	6	52	65	65	71	71	53	94	59	100	23	68	23	68	23	68	68					
48	100	46	6	52	64	64	70	70	48	94	54	100	20	66	20	66	20	66	66					
54	100	45	5	50	63	63	68	68	47	94	53	99	18	64	18	64	18	64	64					
62	100	45	6	51	62	62	68	68	47	94	52	99	17	62	17	62	17	62	62					
72	100	44	7	52	61	61	68	68	46	94	52	98	16	60	16	60	16	60	60					

SITE INDEX: 175

12	85	81	23	85	85	85	85	85	85	85	85	85	85	85	85	85
14	87	69	16	82	79	79	82	82	82	87	82	87	55	84	55	84
16	89	59	13	72	74	74	80	80	78	88	78	89	46	82	46	82
18	91	52	11	63	71	71	78	78	74	89	75	91	41	81	41	81
20	93	46	10	56	67	67	77	77	71	90	73	93	38	79	38	79
24	96	41	9	50	64	64	73	73	65	91	68	96	34	75	34	75
30	99	39	8	47	62	62	70	70	57	92	63	98	29	68	29	68
36	100	39	8	47	60	60	68	68	52	91	58	99	25	64	25	64
42	100	39	8	47	59	59	67	67	48	88	56	99	22	61	22	61
48	100	39	10	49	57	57	67	67	45	84	54	98	20	59	20	59
54	100	38	13	51	55	55	68	68	42	80	52	96	18	56	18	56
62	100	37	16	52	53	53	69	69	39	76	51	91	16	52	16	52
72	100	35	18	53	52	52	70	70	37	72	50	84	15	50	18	53

SITE INDEX: 200

12	80	79	32	80	80	80	80	80	80	80	80	80	80	80	80	80
14	85	58	20	73	72	72	85	85	77	81	77	85	55	78	55	78
16	89	46	15	61	66	66	81	81	70	82	70	89	46	76	46	76
18	92	41	11	52	63	63	74	74	60	83	65	92	41	74	41	74
20	94	38	9	47	60	60	69	69	52	83	63	94	37	72	37	72
24	97	36	7	43	57	57	64	64	47	84	61	97	32	68	32	68
30	99	35	8	42	55	55	63	63	45	85	60	99	28	63	28	63
36	100	35	10	45	54	54	64	64	44	83	58	100	24	58	24	58
42	100	35	13	51	53	53	66	66	42	79	56	98	20	55	20	55
48	100	34	16	52	52	52	68	68	40	76	54	94	18	52	18	54
54	100	34	19	53	51	51	70	70	38	72	53	89	16	50	19	53
62	100	33	21	54	50	50	71	71	35	69	50	82	15	48	21	54
72	100	32	23	55	49	49	72	72	33	65	47	78	13	45	23	55

Table 3.- Percent of cull in Douglas-fir by site and D.B.H. class
Cubic-foot volume of saw-log portion of bole

Cull percentage of gross cubic-foot volume of saw-log portion of bole - indicated by

DBH Class	F. officinalis conk or F. pini conks vertically separated more than 10 feet	Dead or broken top extending into merchant- able bole	Fire scar plus dead or broken top	Single or compact group of F. pini conks -- none separated by more than 10 feet vertical distance, on												
				Lower 1/3 of merchantable bole				Middle 1/3 of merchantable bole				Upper 1/3 of merchantable bole				
				Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)

SITE INDEX: 125 AND UNDER

12	30	16	2	18	15	17	17	19	16	29	18	31	11	27	11	27
14	34	16	4	20	15	17	19	21	14	27	18	31	10	26	10	26
16	37	16	6	22	15	18	21	24	12	26	18	32	9	25	9	25
18	40	16	8	24	15	19	23	27	11	25	19	35	8	24	8	24
20	43	15	11	26	15	19	26	30	11	24	20	35	8	23	11	26
24	49	14	15	29	15	20	30	35	10	24	23	37	7	21	15	29
30	58	14	22	36	15	22	37	44	11	25	25	40	7	21	22	36
36	66	16	28	44	15	24	43	52	11	27	28	45	7	23	28	44
42	70	18	35	53	15	25	50	60	12	30	35	51	6	24	35	53
48	73	22	41	63	16	27	56	68	12	34	41	61	6	28	41	63
54	77	24	48	72	18	29	66	77	14	38	48	72	7	31	48	72

SITE INDEX: 150

12	29	13	2	15	12	14	14	16	10	22	12	24	9	22	9	22
14	34	12	3	15	12	14	15	17	10	22	13	25	8	20	8	21
16	38	12	5	17	12	14	17	19	10	22	15	27	8	19	8	20
18	42	11	6	17	12	15	18	21	10	21	16	28	7	18	8	19
20	45	11	8	19	12	16	20	24	10	21	18	30	7	18	8	19
24	51	11	11	22	13	17	24	28	10	21	21	32	6	17	11	22
30	59	12	17	29	13	21	30	38	10	22	25	37	6	18	17	29
36	65	14	23	37	14	23	37	46	11	25	28	42	6	20	24	38
42	68	16	30	46	14	25	44	55	11	27	32	48	6	22	30	46
48	71	19	36	55	15	26	51	62	11	30	36	55	6	25	36	55
54	74	20	41	61	15	27	56	68	12	32	41	61	6	26	41	61
62	77	20	45	65	16	28	61	73	12	32	45	65	6	26	45	65
72	80	20	47	67	17	29	64	76	12	32	47	67	6	26	47	67

SITE INDEX: 175 AND 200

12	32	17	1	17	17	17	17	18	15	30	16	31	10	27	10	27
14	37	15	2	17	15	17	17	19	13	27	15	29	10	25	10	25
16	41	14	4	18	14	17	18	21	11	25	15	29	9	23	9	23
18	44	13	6	19	13	17	19	23	10	23	16	29	8	21	9	22
20	48	12	8	20	12	17	20	25	10	22	18	30	7	19	9	21
24	53	12	12	24	11	17	23	29	10	22	22	34	6	18	12	23
30	60	12	19	31	11	19	30	38	10	22	26	38	6	18	19	31
36	67	13	25	38	12	21	37	46	10	23	29	42	6	19	25	38
42	72	14	31	45	12	24	43	55	10	24	33	47	6	20	31	45
48	75	16	37	53	13	25	50	62	10	26	37	53	6	22	37	53
54	78	17	40	57	14	26	54	66	10	27	40	57	6	23	40	57
62	81	17	40	57	15	27	55	67	11	28	40	57	6	23	40	57
72	82	17	40	57	15	28	55	68	11	28	40	57	6	23	40	57

Table 4.- Percent of cull in white and red firs by site and D.B.H. class
Cubic-foot volume of saw-log portion of bole

DBH Class	F. officinalis conk or E. tinctorium conks vertically separated more than 5 feet (1)	Old fire scar (2)	Dead or broken top extending into merchant- able bole (3)	Fire scar plus dead or broken top (4)	Cull percentage of gross cubic-foot volume of saw-log portion of bole - indicated by															
					Single or compact group of E. tinctorium conks - none separated by more than 5 feet vertical distance, on															
					Lower 1/3 of merchantable bole					Middle 1/3 of merchantable bole					Upper 1/3 of merchantable bole					
Alone (5)	With fire scar (6)	With dead or broken top (7)	Alone (9)	With fire scar (10)	With dead or broken top (11)	Alone (12)	With fire scar (13)	With dead or broken top (14)	With fire scar (15)	With dead or broken top (16)										
12	9	6	3	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
14	10	7	3	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
16	11	7	2	9	11	11	11	11	11	11	11	11	11	11	11	10	11	10	10	11
18	13	8	2	9	12	12	13	13	13	13	13	13	13	13	13	10	13	10	10	13
20	16	8	2	10	14	14	16	16	15	16	16	16	16	16	16	10	16	10	10	16
24	21	11	2	12	18	18	20	20	19	21	20	21	21	21	21	11	21	11	21	21
30	31	17	2	19	24	24	26	26	25	31	26	31	31	31	31	12	31	12	31	31
36	41	24	3	27	30	30	32	32	28	39	30	41	13	38	13	37				
42	49	30	3	33	34	34	37	37	31	46	33	49	15	43	15	43				
48	56	33	4	37	38	38	42	42	33	52	36	56	15	46	15	46				
54	61	35	4	39	41	41	45	45	34	57	37	61	15	48	15	48				
62	66	37	4	41	43	43	47	47	35	62	39	66	13	50	13	50				

SITE INDEX: 100																			
12	7	7	2	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
14	10	7	2	8	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
16	13	7	3	9	11	11	13	13	13	13	13	13	13	10	12	10	12	10	12
18	15	7	3	9	13	13	15	15	15	15	15	15	15	10	14	10	14	10	14
20	18	8	3	10	15	15	17	17	16	17	17	17	18	10	16	10	16	10	16
24	24	9	3	12	18	18	20	20	18	23	20	24	11	20	11	20	11	20	11
30	33	13	3	16	22	22	25	25	20	30	23	32	11	24	11	24			
36	42	17	3	19	26	26	29	29	22	37	25	39	11	28	11	28			
42	50	21	3	23	30	30	33	33	24	42	26	45	11	32	11	32			
48	57	23	3	26	34	34	36	36	25	47	27	49	11	34	11	34			
54	63	25	4	28	36	36	39	39	26	50	28	53	11	35	11	36			
62	68	27	5	32	38	38	42	42	26	53	30	57	11	37	11	38			
72	70	28	7	35	37	38	44	45	27	55	33	61	11	39	12	40			

SITE INDEX: 125 AND 150																			
12	7	7	2	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
14	10	7	2	8	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10
16	13	7	3	9	11	11	13	13	13	13	13	13	13	10	12	10	12	10	12
18	15	7	3	9	13	13	15	15	15	15	15	15	15	10	14	10	14	10	14
20	18	8	3	10	15	15	17	17	16	17	17	17	18	10	16	10	16	10	16
24	24	9	3	12	18	18	20	20	18	23	20	24	11	20	11	20	11	20	11
30	33	13	3	16	22	22	25	25	20	30	23	32	11	24	11	24			
36	42	17	3	19	26	26	29	29	22	37	25	39	11	28	11	28			
42	50	21	3	23	30	30	33	33	24	42	26	45	11	32	11	32			
48	57	23	3	26	34	34	36	36	25	47	27	49	11	34	11	34			
54	63	25	4	28	36	36	39	39	26	50	28	53	11	35	11	36			
62	68	27	5	32	38	38	42	42	26	53	30	57	11	37	11	38			
72	70	28	7	35	37	38	44	45	27	55	33	61	11	39	12	40			

SITE INDEX: 175

12	11	7	2	9	11	11	11	11	11	11	11	11	11	11	11	11	11
14	9	6	2	8	9	9	9	9	9	9	9	9	9	9	9	9	9
16	9	4	2	6	9	9	9	9	9	9	9	9	9	9	9	9	9
18	11	4	2	6	10	10	11	11	11	11	11	11	11	11	11	11	11
20	16	5	2	7	12	12	14	14	14	16	14	16	9	14	9	9	14
24	24	8	3	11	16	16	19	19	17	23	18	24	10	18	10	18	18
30	34	12	3	15	20	20	23	23	19	30	22	33	11	23	11	23	23
36	43	15	4	19	24	24	28	28	20	34	24	39	10	25	11	26	26
42	50	18	5	23	26	27	31	32	21	38	26	44	9	27	11	29	29
48	56	20	7	27	29	30	36	37	21	40	28	48	9	29	12	31	31
54	60	20	10	30	30	31	40	42	22	41	32	52	9	29	13	32	32
62	65	20	14	34	30	33	44	47	22	42	35	54	9	29	14	34	34
72	70	20	17	37	31	34	48	51	22	42	37	56	9	29	17	36	36

SITE INDEX: 200

12	11	8	2	10	11	11	11	11	11	11	11	11	11	11	11	11	11
14	11	6	2	8	11	11	11	11	11	11	11	11	10	11	11	11	11
16	12	5	2	7	10	10	11	11	12	12	12	12	8	12	8	12	12
18	14	4	2	6	11	11	12	12	12	14	12	14	8	12	8	12	12
20	17	5	2	7	12	12	13	13	13	16	13	17	8	13	8	13	13
24	23	7	2	9	14	14	16	16	14	20	15	22	8	15	8	15	15
30	33	11	4	15	18	19	22	23	16	27	20	31	8	19	9	20	20
36	42	14	8	22	22	23	30	31	17	30	25	38	8	22	10	24	24
42	49	16	11	27	24	26	35	37	18	34	29	45	8	24	12	28	28
48	55	17	14	31	26	28	40	42	19	36	33	49	8	25	14	31	31
54	60	17	18	35	27	29	45	47	19	36	35	52	8	25	18	35	35
62	65	18	20	38	28	31	48	51	20	38	37	53	8	26	21	38	38
72	68	18	22	40	29	33	51	55	20	38	38	54	8	26	22	39	39

Table 5.- Percent of cull in Douglas-fir by site and D.B.H. class
Cubic-foot volume of entire bole

Cull percentage of gross cubic-foot volume - stump to 4-inch i.b. - indicated by

DBH Class	F. officinalis conk or F. pini conks vertically separated more than 10 feet	Old fire scar	Dead or broken top extending into merchant- able bole	Fire scar plus dead or broken top	Single or compact group of F. pini conks - none separated by more than 10 feet vertical distance, on											
					Lower 1/3 of merchantable bole				Middle 1/3 of merchantable bole				Upper 1/3 of merchantable bole			
					With fire scar and dead or broken top	With dead or broken top	With fire scar and dead or broken top	With dead or broken top	With fire scar and dead or broken top	With dead or broken top	With fire scar and dead or broken top	With dead or broken top	With fire scar and dead or broken top	With dead or broken top	With fire scar and dead or broken top	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
12	30	11	32	43	11	11	43	44	11	17	43	49	9	20	40	51
14	33	12	29	41	12	12	41	41	11	19	40	48	8	20	35	47
16	36	13	28	40	12	13	40	41	11	20	38	48	8	20	32	44
18	39	13	28	39	12	14	39	41	11	21	36	48	7	20	29	42
20	42	13	28	39	12	15	38	41	11	21	34	47	7	20	28	40
24	50	13	28	39	13	16	38	43	11	23	33	46	7	20	28	40
30	58	14	29	43	14	20	41	48	11	24	32	46	7	21	29	42
36	64	15	32	47	14	22	46	55	11	26	32	47	6	21	32	46
42	68	18	36	54	15	24	51	62	11	28	36	53	6	23	36	54
48	72	21	42	63	17	26	59	69	13	31	42	63	6	26	42	63
54	77	23	53	75	17	29	66	77	14	37	53	75	6	29	53	75

SITE INDEX: 125 AND UNDER

12	30	11	32	43	11	11	43	44	11	17	43	49	9	20	40	51
14	33	12	29	41	12	12	41	41	11	19	40	48	8	20	35	47
16	36	13	28	40	12	13	40	41	11	20	38	48	8	20	32	44
18	39	13	28	39	12	14	39	41	11	21	36	48	7	20	29	42
20	42	13	28	39	12	15	38	41	11	21	34	47	7	20	28	40
24	50	13	28	39	13	16	38	43	11	23	33	46	7	20	28	40
30	58	14	29	43	14	20	41	48	11	24	32	46	7	21	29	42
36	64	15	32	47	14	22	46	55	11	26	32	47	6	21	32	46
42	68	18	36	54	15	24	51	62	11	28	36	53	6	23	36	54
48	72	21	42	63	17	26	59	69	13	31	42	63	6	26	42	63
54	77	23	53	75	17	29	66	77	14	37	53	75	6	29	53	75

SITE INDEX: 150

12	28	9	32	41	9	9	39	41	7	16	39	48	6	15	38	47
14	33	9	28	37	9	11	36	39	7	16	35	44	6	15	31	40
16	38	9	25	34	9	12	34	37	7	16	32	41	6	15	27	36
18	41	9	24	33	9	12	33	36	8	17	31	40	6	15	25	34
20	44	9	23	31	9	13	32	36	8	17	30	39	6	15	24	33
24	50	10	22	32	9	15	31	37	8	17	29	39	6	16	22	32
30	58	11	24	35	10	19	34	41	8	19	30	41	6	17	24	34
36	63	13	28	41	14	21	42	48	10	23	31	44	6	19	28	41
42	68	17	33	50	15	23	48	57	11	28	33	50	6	23	34	51
48	71	19	38	57	15	25	54	64	12	31	38	56	6	25	40	59
54	74	20	43	63	15	26	58	69	12	31	43	63	6	26	43	63
62	76	20	46	66	16	27	62	73	12	31	46	66	6	26	46	66
72	80	20	49	68	16	28	64	76	12	31	49	69	6	26	49	69

17 SITE INDEX: 175 AND 200

12	32	10	32	42	10	11	42	43	9	17	41	49	8	18	39	49
14	35	10	30	40	10	12	40	42	9	17	39	47	7	17	37	47
16	39	10	28	38	10	12	38	40	9	17	37	45	7	17	34	44
18	42	10	27	36	10	13	37	39	8	17	35	44	6	16	30	40
20	45	10	25	35	10	14	36	39	8	17	33	42	6	16	26	36
24	51	10	24	34	11	15	35	39	7	17	31	41	5	15	24	34
30	59	10	25	35	11	17	36	42	8	18	32	42	5	15	25	35
36	65	11	29	40	11	19	40	47	9	20	33	44	5	16	29	40
42	70	13	34	47	12	21	46	55	9	22	37	50	5	18	34	47
48	75	15	40	55	12	24	52	64	10	25	41	56	5	20	40	55
54	78	17	43	60	12	26	55	69	10	27	43	60	5	22	43	60
62	81	17	43	60	13	27	56	70	10	27	43	60	5	22	43	60
72	81	17	43	60	14	28	57	71	10	27	43	60	5	22	43	60

Table 6.- Percent of cull in white and red firs by site and D.B.H. class
Cubic-foot volume of entire bole

DBH Class	F. officinalis conk or E. tinctorium conks vertically separated more than 5 feet (1)	Old fire scar (2)	Dead or broken top extending into merchant- able bole (3)	Fire scar plus dead or broken top (4)	Cull percentage of gross cubic-foot volume - stump to 4-inch i.b. - indicated by Single or compact group of E. tinctorium conks - none separated by more than 5 feet vertical distance, on											
					Lower 1/3 of merchantable bole				Middle 1/3 of merchantable bole				Upper 1/3 of merchantable bole			
					Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top	Alone	With fire scar	With dead or broken top	With fire scar and dead or broken top
					(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
SITE INDEX: 100																
12	8	4	37	41	7	7	41	41	8	8	41	41	8	8	41	41
14	10	4	34	38	8	8	38	38	8	8	38	38	9	9	38	38
16	11	6	29	35	8	8	35	35	9	9	36	36	10	10	35	36
18	13	6	26	32	10	10	34	34	11	11	34	34	10	11	32	34
20	15	8	24	32	11	11	33	33	13	13	33	33	10	13	29	34
24	20	10	17	27	15	15	32	32	18	19	31	34	10	19	24	34
30	29	16	11	27	23	23	34	34	23	28	32	38	11	27	21	36
36	39	23	8	31	28	28	36	36	27	37	34	45	13	36	19	40
42	47	28	7	35	33	33	40	40	29	44	36	51	14	42	18	45
48	55	32	7	39	37	37	44	44	31	51	38	56	15	47	18	50
54	61	34	7	41	40	40	47	47	33	56	39	61	15	49	18	52
62	66	36	6	42	43	43	49	49	34	61	40	67	15	50	15	51
SITE INDEX: 125 AND 150																
12	7	4	38	41	6	6	41	41	7	7	41	41	7	7	41	41
14	10	4	32	36	8	8	38	38	9	9	38	38	9	9	37	38
16	12	4	27	31	9	9	35	35	12	12	34	34	10	12	32	35
18	14	5	22	27	11	11	33	33	13	13	32	33	10	14	28	32
20	17	6	18	24	13	13	31	31	14	15	30	31	10	16	26	30
24	23	8	13	21	16	16	29	29	17	20	29	31	11	19	22	28
30	32	12	9	21	20	20	29	29	19	29	28	37	11	23	18	29
36	41	16	7	23	25	25	31	31	21	35	28	42	11	27	15	30
42	49	19	6	25	28	28	34	34	23	41	28	46	11	30	13	32
48	56	22	5	27	32	32	36	36	24	45	29	50	11	32	12	34
54	63	24	5	29	34	34	39	39	25	48	30	53	11	34	12	36
62	68	27	6	33	36	37	42	43	25	51	31	57	11	36	12	38
72	70	28	8	36	36	38	44	46	26	54	34	62	11	39	13	41

SITE INDEX: 175

12	9	5	38	42	8	8	43	43	9	9	43	43	9	9	43	43
14	8	3	32	35	7	7	36	36	7	7	37	37	7	8	37	37
16	9	3	27	30	7	7	33	33	8	8	34	34	6	9	31	34
18	12	3	22	25	8	8	30	30	10	10	31	31	7	10	28	31
20	15	5	18	23	11	11	29	29	12	14	29	30	9	12	25	30
24	23	8	13	21	15	15	28	28	15	19	28	33	10	16	20	28
30	33	12	9	21	20	20	29	29	17	26	26	36	10	21	16	27
36	41	14	9	23	22	22	31	31	18	32	27	41	9	23	15	28
42	48	17	9	26	25	26	34	34	20	37	29	45	9	26	14	31
48	54	19	10	29	27	28	37	38	21	40	31	50	9	28	14	33
54	58	20	13	33	29	31	42	44	21	41	34	53	9	29	15	35
62	64	20	16	36	30	33	46	48	21	41	36	56	9	29	16	36
72	70	20	18	38	31	34	49	52	21	41	38	56	9	29	18	38

SITE INDEX: 200

12	9	5	41	45	7	7	45	45	9	9	45	45	8	9	45	45
14	10	4	30	34	8	8	36	36	9	9	37	37	8	9	35	36
16	12	4	23	27	8	8	31	31	10	10	32	32	8	10	29	31
18	14	3	20	23	9	9	28	28	10	11	27	29	8	11	24	27
20	16	4	17	21	10	10	26	26	11	13	25	28	8	12	21	25
24	21	6	13	19	12	12	25	25	12	18	24	30	8	14	17	23
30	31	10	11	21	17	17	28	28	15	24	25	35	8	18	16	26
36	40	13	10	23	21	22	31	32	16	29	26	39	8	21	15	28
42	48	16	12	28	23	25	35	37	17	33	29	45	8	24	15	31
48	54	17	16	33	25	27	41	43	18	35	34	51	8	25	16	33
54	59	17	19	36	26	28	45	47	19	36	37	54	8	25	19	36
62	64	17	22	39	27	30	49	52	19	36	38	55	8	25	22	39
72	68	17	23	40	29	32	52	55	19	36	38	55	8	25	23	40

Ponderosa and Sugar Pines

The percent of cull in the two principal commercial pines of the Coast Range Pine subregion in northwestern California, ponderosa pine and sugar pine, is considerably lower than in the true firs and Douglas-fir. Because of the relatively small cull percentage and the more uniform occurrence of cull within a subregion in these two species, they readily lend themselves to the use of flat cull factors. Also, indicators of cull are less reliable in these species, and a considerable proportion of "hidden" cull exists. For this reason, average cull factors were determined for the entire subregion. These are given for Dunning's tree classes by tree-class groups in table 7.

Dunning's classification^{2/}, based largely on tree age and vigor, includes young trees up to about 150 years of age in classes 1, 2 and 6. Classes 3 and 4 include mature trees between the ages of 150 and 300 years. Over-mature trees, more than 300 years old, are in class 5. Class 7 is for mature and over-mature suppressed trees. In table 7, class 7 trees are included with the young trees to form a group which ordinarily is not cut in many logging operations.

In table 7 the gross board-foot merchantable volume applies to the sawlog portion of the bole; that is, from an 18-inch stump to a utilizable top, as shown in figure 12, page 30.

Basic data for the cull factors in table 7 were from early studies made by the Division of Forest Pathology on Forest Service sale areas in the Coast Range Pine subregion and from recent studies of cull on 7 areas of ponderosa and 5 areas of sugar pine in this subregion. A total of approximately 1000 trees were measured.

Table 7.- Percent cull in ponderosa and sugar pine in the
Coast Range Pine Subregion of California -
by Dunning's tree classes

Species	Tree classes	Cull as percent of gross board-foot merchantable volume (Scribner Decimal C)
Ponderosa pine	1,2,6,7	2.4
	3 and 4	3.3
	5	4.7
Sugar pine	1,2,6,7	5.6
	3 and 4	6.1
	5	11.4

^{2/} Dunning, Duncan. A tree classification for the selection forests of the Sierra Nevada. Jour. Agr. Res. 36(9):755-771. May 1, 1928.

California Incense-cedar

California incense-cedar is probably the most defective coniferous species in the State. There is considerable variation in amount of cull between stands, especially stands in different subregions, but since there are no satisfactory cull indicators on standing trees, flat cull factors were considered the most reliable method of indicating cull.

The flat factors for incense cedar are given in table 8 for each of Dunning's tree classes^{3/}. These cull factors apply to incense-cedar growing in Lassen, Modoc, Shasta, and Siskiyou Counties as well as in the area designated on the map opposite page 1.

Early studies by the Division of Forest Pathology involving the detailed measurements of 495 dissected incense-cedar trees in northern California supplied the basis for the cull factors in table 8.

Table 8.- Percent cull in incense-cedar in the Coast Range Pine and Eastside Sierra Pine (in northern part^{1/}) Subregions of California - by Dunning's tree classes

Tree class	Cull as percent of gross volume		
	In board feet (Scribner Dec. C)		In cubic feet, 18-inch stump to utilizable top ^{2/}
	18-inch stump to utilizable top ^{2/}	18-inch stump to tip	
1		4	4
6		7	3
2		10	5
3		21	18
4		31	24
7		35	21
5		77	68

^{1/} Lassen, Modoc, Shasta, and Siskiyou Counties.

^{2/} Utilizable top as shown in fig. 12, page 30

^{3/} See footnote number 2, page 20.

CULL FACTORS FOR HARDWOOD SPECIES

The principal hardwood trees of the Coast Range Pine and Redwood--Douglas-fir subregions are, in general, fairly defective. There is considerable variability in extent of cull between species; however, in the more defective species the great bulk of defect occurs in cull trees. Any sawlog tree more than 60 percent (board-foot volume) defective is considered a cull tree. If only merchantable trees are considered, the cull between species is more uniform.

All trees 11 inches d.b.h. and over that contained at least one 8-foot sawlog with a top d.i.b. of 10 inches or more were classed as sawlog trees.

Cordwood trees include all trees 4 to 10 inches d.b.h. and all larger ones that will not make an 8-foot sawlog with top d.i.b. of 10 inches. Usually, these smaller trees were more sound than sawlog trees.

Cull in branches was recorded separately. In sawlog trees, any branch that contained at least one 8-foot sawlog, with a top d.i.b. of 10 inches or more, was considered a fork of the bole and not a branch.

Flat factors were determined for each of the principal hardwood species in the Coast Range Pine and Redwood-Douglas-fir subregions. The cull factors for the sawlog portion of sawlog trees are given in both cubic-foot and board-foot Scribner for all trees, cull trees, and for trees not cull, in table 9. The cull factors for branches, for boles, and for entire trees, from the stump to a 4-inch d.i.b., are given in percent of cubic-foot volumes for cordwood trees in table 10, and for sawlog trees, including all trees, and trees not cull, in table 11.

In table 10, the stump heights for cordwood trees were as follows:

<u>d.b.h. (inches)</u>	<u>Stump height (inches)</u>
4	11
6	13
8	15
10	17
11 and over	18

In tables 9 and 11, the stump height for sawlog trees was 18 inches. All logs were 8 feet plus trim in length with a minimum small end diameter of 10 inches. Any log that was less than 50 percent sound by Scribner board-foot scale was considered totally cull in the board-foot computations.

Data for the cull factors in tables 9, 10 and 11 were obtained from the dissection and detailed measurement of 1,006 trees on about 40 miles of power line right-of-way and at 3 tanoak operations in northern California, as follows:

Tree species	Basis, number of trees
Oregon white oak	175
California black oak	258
Canyon live oak	75
Tanoak	90
Golden chinquapin	40
Red alder	112
Pacific madrone	180
California-laurel	15
Oregon ash	23
Bigleaf maple	38
All species	1,006

Table 9. - Cull factors for sawlog portion^{1/} of the principal hardwood species in northwestern California.

Species	Percent cull, for gross volume based on --					
	Cubic feet			Board feet - Scribner		
	All trees	Cull trees	Trees not cull	All trees	Cull trees	Trees not cull
Oregon white oak	31	55	4	54	91	12
California black oak	26	64	7	43	91	19
Canyon live oak	14	39	8	33	84	22
Tanoak	13	39	8	33	80	26
Golden chinquapin	14	36	5	35	83	15
Red alder	3	43	1	7	100	4
Pacific madrone	10	33	4	30	79	17
California-laurel	3	-	3	18	-	18
Oregon ash	3	-	3	12	-	12
Bigleaf maple	7	34	3	21	82	12

1/ Sawlog portion is from stump to a top diameter of 10 inches (or more) inside bark.

Table 10. - Cull factors for entire^{1/} cordwood trees of the principal hardwood species in northwestern California.

Species	Percent cull ^{2/} for gross cubic-foot volume in --		
	Bole	Branches	Entire tree
Oregon white oak	6	T	5
California black oak	9	19	11
Canyon live oak	1	T	1
Tanoak	2	5	2
Golden chinquapin	2	-	2
Red alder	2	0	2
Pacific madrone	2	0	2
California-laurel	10	0	10
Oregon ash	5	0	5
Bigleaf maple	0	0	0

^{1/} From stump to minimum top diameter of 4 inches inside bark.

^{2/} Cull percentages are given to the nearest whole number, and any cull amounting to less than 0.5 percent is indicated by the letter "T", signifying trace.

Table 11. - Cull factors for entire^{1/} sawlog trees of the principal hardwood species in northwestern California

Species	Percent cull ^{2/} , for gross cubic-foot volume in --									
	Bole		Branches			Entire tree				
	:Trees: All :Cull : not :trees: :trees: :cull: :trees:		:Trees: All :Cull : not :trees: :trees: :cull: :trees:			:Trees: All :Cull : not :trees: :trees: :cull: :trees:				
	: :	: :	: :	: :	: :	: :	: :	: :	: :	: :
Oregon white oak	27	48	3	21	32	10	26	45	4	
California black oak	25	55	6	28	53	14	26	55	7	
Canyon live oak	12	32	7	7	37	3	12	33	6	
Tanoak	11	35	7	2	T	2	11	35	7	
Golden chinquapin	12	32	4	29	31	0	13	32	4	
Red Alder	T	39	T	0	0	0	T	39	T	
Pacific madrone	8	26	3	13	19	11	9	26	4	
California-laurel	7	-	7	0	-	0	7	-	7	
Oregon ash	3	-	3	0	-	0	3	-	3	
Bigleaf maple	5	18	2	7	3	8	5	17	3	

^{1/} From stump to minimum top diameter of 4 inches inside bark.
^{2/} Cull percentages are given to the nearest whole number, and any cull amounting to less than 0.5 percent is indicated by the letter "T", signifying trace.

Common and Scientific Names of Trees and Fungi Mentioned

Bigleaf maple	<u>Acer macrophyllum</u> Pursh.
California black oak	<u>Quercus kelloggii</u> Newb.
California incense-cedar	<u>Libocedrus decurrens</u> Torr.
California-laurel	<u>Umbellularia californica</u> (Hook. and Arn.) Nutt.
California red fir	<u>Abies magnifica</u> A. Murr.
Canyon live oak	<u>Quercus chrysolepis</u> Liebm.
Douglas-fir	<u>Pseudotsuga taxifolia</u> (Poir.) Britton
Golden chinquapin	<u>Castanopsis chrysophylla</u> (Dougl.) A. DC.
Oregon ash	<u>Fraxinus oregona</u> Nutt.
Oregon white oak	<u>Quercus garryana</u> Dougl.
Pacific madrone	<u>Arbutus menziesii</u> Pursh.
Ponderosa pine	<u>Pinus ponderosa</u> Laws.
Red alder	<u>Alnus ruba</u> Bong.
Redwood	<u>Sequoia sempervirens</u> (D. Don) Endl.
Sugar pine	<u>Pinus lambertiana</u> Dougl.
Tanoak	<u>Lithocarpus densiflorus</u> (Hook. and Arn.) Rehd.
White fir	<u>Abies concolor</u> (Gord. and Glend.) Hoopes
Indian paint fungus	<u>Echinodontium tinctorium</u> E. and E.
Quinine fungus	<u>Fomes officinalis</u> (<u>laricis</u>) (Vill.) Fr.
Ring scale fungus	<u>Fomes (Trametes) pini</u> (Thore) Lloyd
Velvet top fungus	<u>Polyporus schweinitzii</u> Fr.

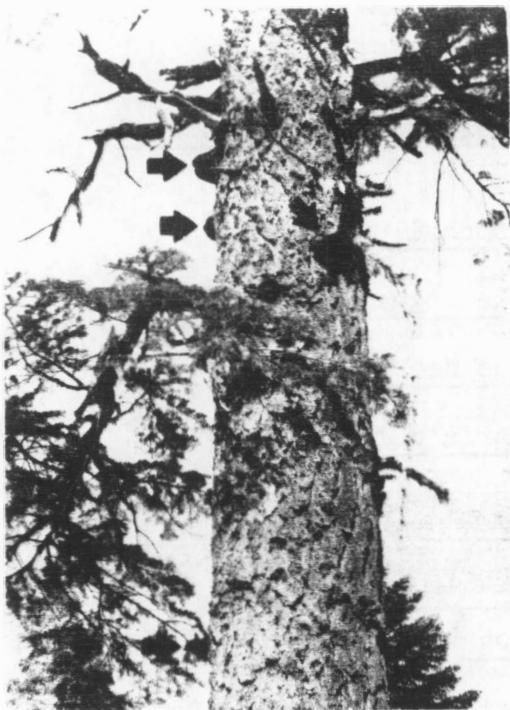


Fig. 1



Fig. 2

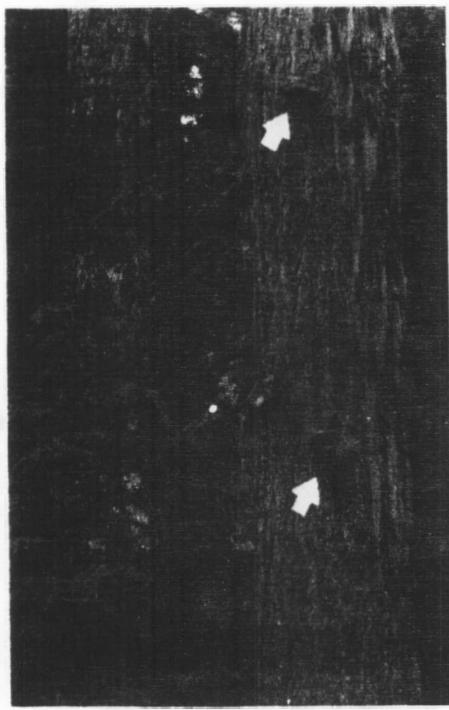


Fig. 3

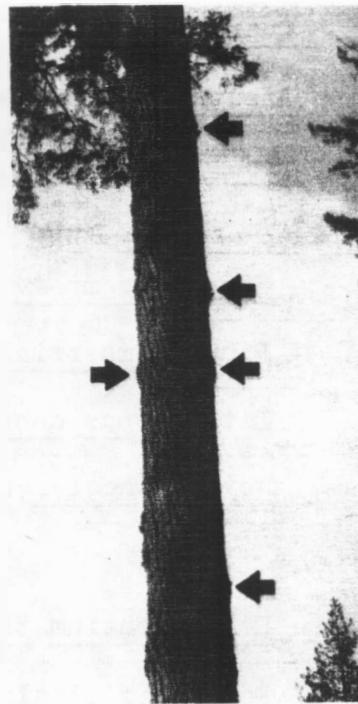


Fig. 4



Fig. 5

Fig. 1 and 2 - Conks of the Indian paint fungus on white fir.

Fig. 3 - Conks of the ring scale fungus on Douglas-fir. (Photograph by
J. S. Boyce and R. E. Mc Ardle.)

Fig. 4 - Swollen knots on Douglas-fir indicating cull from ring scale fungus.

Fig. 5 - Burl-like swellings on Douglas-fir which are not indicators of cull.



Fig. 6



Fig. 7

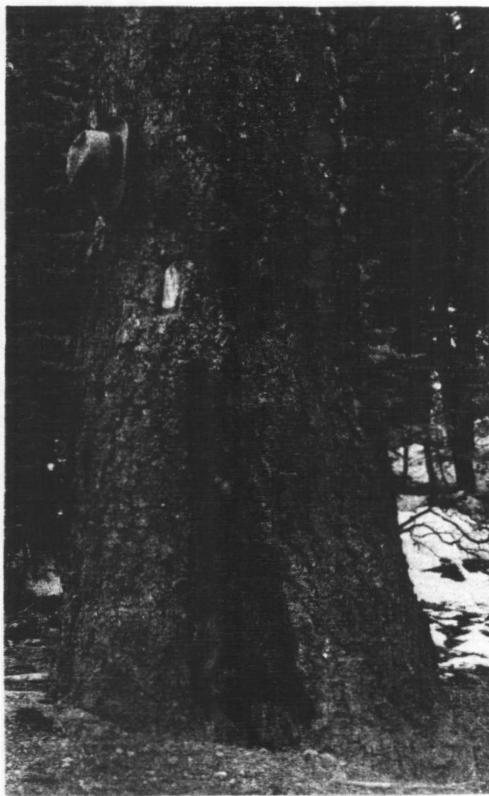


Fig. 8

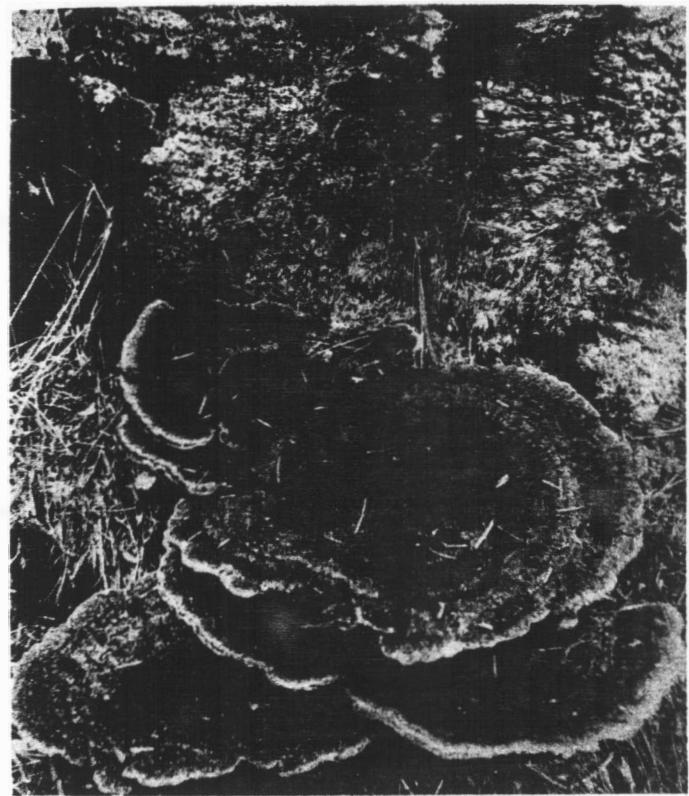


Fig. 9

Fig. 6 - Conk of the quinine fungus on Douglas-fir.

Fig. 7 - Dried conk of the quinine fungus.

Fig. 8 - Old fire scar in white fir.

Fig. 9 - Fresh conk of the velvet top fungus growing

on the ground at the base of a Douglas-fir.

(Photograph by H. J. Rust.)

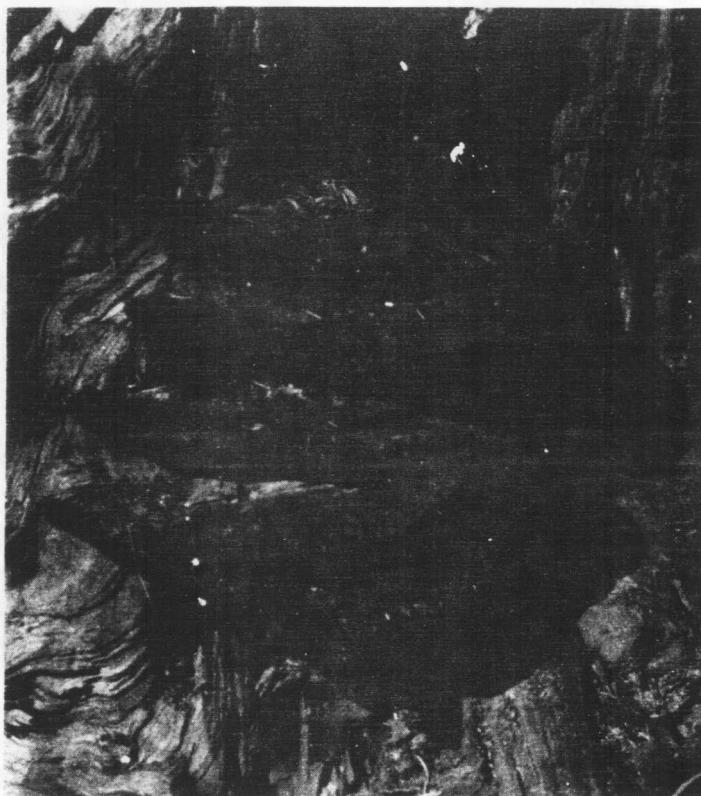


Fig.10

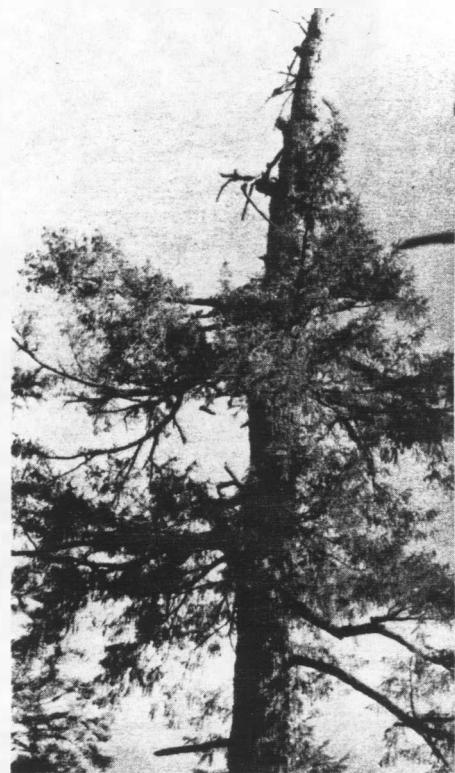


Fig.11

Fig.10 - Dried and darkened conks of the velvet top fungus in a scar on the butt of a tree.

Fig.11 - Dead and broken top in a Douglas-fir tree.

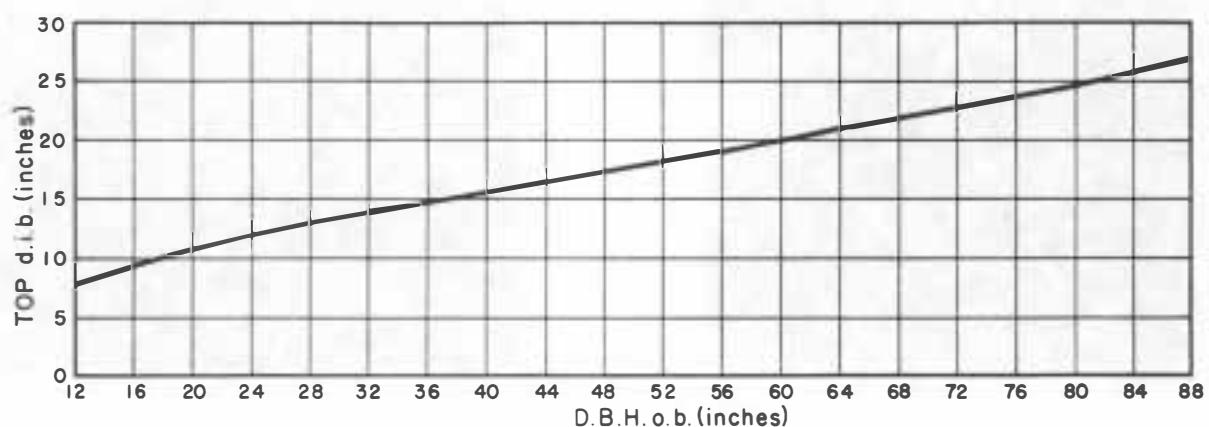


Fig.12 - Average top utilization by d.b.h. classes on Forest Service timber sales in California in 1945. (Reprinted from Research Note No. 60, California Forest and Range Experiment Station, April, 1949.)